POWDER

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E-Mobility
E-Mobility

Power

Battery / Charging / Energy Management
BATTERY
Unified Cell

2023
Battery costs -50% in entry segment
CHARGING
High Power Charging

GLOBAL NETWORK
ENERGY MANAGEMENT
Power as Core Competence
NEW TECHNOLOGY DIVISION:

WE ARE THE POWERHOUSE OF VOLKSWAGEN
TWO MAIN PILLARS

BATTERY CELL & SYSTEM

CHARGING & ENERGY
FIRST CHALLENGE: SCALE VOLUME TO HUGE SPREAD OF PRODUCT PORTFOLIO
IF YOU HAVE THE VOLUME...
THE NEXT CHALLENGE WILL BE

TECHNOLOGY, TIMING, AND PRICE!
THERE IS NEED FOR SPEED!
MINDSET CHANGE IN FUNCTIONAL RESPONSIBILITIES
CLOSED LOOP APPROACH

RECYCLING
BATTERY CELL
SECOND USE
BATTERY SYSTEMS
FIRST USE
AND A FUNDAMENTAL MINDSET CHANGE IN TECHNOLOGY SETUP

CURRENT APPROACH

UNIFIED CELL

Concept cars
THE INTELLIGENCE OF THE BATTERY CELL IS INSIDE
ACTUAL PRODUCT PORTFOLIO SHOWS POSSIBLE UNIFIED CELL UTILIZATION OF 80%
ROLLOUT UNIFIED CELL CONCEPT

STARTS 2023

2023

80%

2030
REACHING COST TARGETS
WITH UNIFIED CELL CONCEPT

ENTRY
COST: -50%
Inexpensive Chemistry

VOLUME
COST: -30%
Mainstream Chemistry

SPECIFIC SOLUTIONS
COST: +xx%
High end chemistry for high performance

VARIETY IN CELL CHEMISTRY
VARIETY IN CHEMISTRY AND DESIGN
THE INTELLIGENCE OF THE BATTERY CELL IS INSIDE

ENTRY
IRON PHOSPHATE

VOLUME
HIGH MANGANESE

SPECIFIC SOLUTIONS
NICKEL MANGANESE COBALT

SOLID STATE
MOST IMPORTANT CONTROL LEVERS FOR BATTERY FUTURE COMPETITIVENESS

ANODE
CHARGING TIME

CATHODE
COSTS AND RANGE

SEPARATOR
ELECTROLYTE
CATHODE

CONTROL LEVER FOR SUSTAINABLE SUPPLY CHAIN, COSTS AND RANGE
CATHODE
CONTROL LEVER FOR SUSTAINABLE
SUPPLY CHAIN, COSTS AND VEHICLE RANGE

STATE OF THE ART - NMC-CELL

CATHODE

- Nickel
- Manganese
- Cobalt

CATHODE CELL COST SHARE
40%

CATHODE RANGE IMPACT
90%
CATHODE
ROBUST AND INEXPENSIVE CHEMISTRY FOR ENTRY VEHICLES

LFP-CELL

CATHODE

- Iron-Phosphate
- Nickel
- Manganese
- Cobalt

COSTS
0% 100%

RANGE
0% 100%
CATHODE
FUTURE BEST COST TO VALUE FOR MAINSTREAM CHEMISTRY

HI-MN-CELL

CATHODE

- Nickel
- Manganese
- Cobalt

COSTS
0% 100%

RANGE
0% 100%
ANODE

CONTROL LEVER FOR
CHARGING PERFORMANCE
ANODE
CONTROL LEVER FOR CHARGING PERFORMANCE

STATE OF THE ART – GRAPHITE

ANODE

- Synthetic graphite

ANODE CHARGE TIME IMPACT
100%

ANODE RANGE IMPACT
10%
ANODE
SILICON ANODE SIGNIFICANTLY REDUCES CHARGING TIME AND IMPROVES RANGE

HI-SI-CELL

ANODE

- Synthetic graphite
- Silicon

CHARGING TIME
0% 100%

RANGE
0% 110%
SOLID STATE

SIMPLER DESIGN LEADS TO HIGHER PERFORMANCE AND LOWER COSTS
SOLID STATE BATTERY CELL
SIMPLER DESIGN LEADS TO HIGHER PERFORMANCE

STATE OF THE ART

SOLID STATE
SOLID STATE BATTERY CELL
BEST IN CLASS CHARGING TIME AND INCREASED RANGE

SOLID STATE BATTERY

CHARGING TIME
0%  100%

RANGE
0%  100%  130%
ULTRA FAST CHARGING WILL IMPROVE EV LONG DISTANCE CAPABILITY

VOLKSWAGEN ID.4 PRO [77 kWh]

**Distance**
450 km / 280 mi

**Charging Time**
- Today: ~25 min
- Until 2025: ~17 min
- After 2025: ~12 min

- Los Angeles: 435 km / 270 mi
- Las Vegas: 430 km / 267 mi
- Munich: 433 km / 269 mi
- Beijing: 430 km / 267 mi
COST-SPREAD  BATTERY  SYSTEM
MAIN OBJECTIVE FOR BEV RAMP UP

Volume

Time to market

Costs
MAIN OBJECTIVE FOR BEV RAMP UP

Volume

Time to market

Costs
VOLKSWAGEN EXPANDS SCOPE ALONG VALUE CHAIN

Expand scope  Supply Chain Partnership  VOLKSWAGEN

Mining  Chemistry  Cell factory  Car factory  Recycling

Cell value: 80%  20%
NEW STRONG PARTNERSHIPS – KEY TO FUTURE SUCCESS!
STATE OF THE ART BATTERY CELL PRODUCTION
INVESTMENT AND ENERGY INTENSE PROCESSES

COMPLEX PRODUCTION PROCESS
HIGH INVESTMENT
HIGH ENERGY CONSUMPTION

ASSEMBLY
INTENSE CYCLE TIME

FINISH
INTENSE CYCLE TIME
CLOSED LOOP APPROACH

BATTERY SYSTEMS
REUSING 95% OF THE RAW MATERIALS THROUGH HYDROMETALLURGY PROCESS
The first plant for recycling used electric car batteries! Production in Salzgitter started in January 2021.
1. Produce cathodes from recycled material: saving more than one ton of CO2 per vehicle

2. Ecologically and economically sustainable effect

3. The costs fall, the customer benefit is increase
LOCALIZATION AND VOLUME STRATEGY
THROUGH GREEN DEAL SHARE OF BEVs INSIDE VOLKSWAGEN GROUP WILL INCREASE...

BEV SHARE GROUP 2030

from 30%
THROUGH GREEN DEAL SHARE OF BEVs INSIDE VOLKSWAGEN GROUP WILL INCREASE...

BEV SHARE GROUP 2030
inkl. Green Deal

to 60%
This will create a demand of 240 GWH for Volkswagen in Europe.

That means: $6 \times 40$ GWH!
FIRST PLANT: NORTHVOLT

Start of production 2023
up to 40 GWh

Skellefteå

1st
Actual setup

Actual design

14 GWh
Skellefteå

16 GWh
Salzgitter

ON TOP

New setup

Unified cell premium
Skellefteå by Northvolt

Up to 40 GWh

Unified cell volume
Salzgitter by Volkswagen

Up to 40 GWh
CLEANER PROJECT SETUP
BUNDLING RESOURCES
LESS COMPLEXITY
FASTER RAMP UP
HIGHER VOLUME OUTPUT
SECOND PLANT: SALZGITTER

Start of production 2025
up to 40 GWh
SECOND WAVE OF BATTERY TECHNOLOGY

GWH WORLDWIDE

INHOUSE

KEY SUPPLIERS

2021

2030
A FUTURE SUCCESS

DEPENDS ON A STRONG COLLABORATION

EXTERNAL PARTNERS

VOLKSWAGEN

VOLKSWAGEN GROUP

GOVERNMENT
HOW TO REACH COST TARGETS

Cell design: -15%
Production process: -10%
Cathode / anode material: -20%
Battery system concept: -5%

Costs up to -50%
KEY TAKE-AWAYS

- Technology roadmap with possible unified cell utilization of 80%

- Action fields to achieve cost targets defined

- Closed Loop process installed

- SOLID LOCALIZATION STRATEGY to secure volume and timing
TWO MAIN PILLARS

BATTERY CELL & SYSTEM

CHARGING & ENERGY
Among the **Top 3 reasons to NOT buy an electric car:**

**CHARGING INFRASTRUCTURE**
DIFFERENT CITIES, DIFFERENT CHALLENGES
Volkswagen covering
most important e-mobility markets
Our HPC-Boost-Program for Europe
Our HPC-Boost-Program for Europe by 2025

8,000 HPC Points

Starting 2021

United Kingdom

LONDON

Starting 2021

Germany

BERLIN

bp
Our contribution: We will expand today’s HPC network in Europe by factor 5 until 2025.
Our HPC-Boost-Program for Europe

about **18,000**
HPC points by 2025

1/3
of essential HPC Infrastructure in Europe
FLEXPole

2x DC UP TO 150 kW

BATTERY BUFFER

2nd LIFE OPPORTUNITY

GRID INDEPENDENT

2 PRODUCTION SITES
Suzhou [China], Hanover [Germany]
INNOVATIONS MADE BY VOLKSWAGEN GROUP COMPONENTS
BEVs to become smart charging devices for solar and grid integration
The car as a mobile power bank
BiDirectional charging enables car-owners to become their own utility.
Mobility and renewable energy are complementary.

5 Days

200 km / 125 miles driving

House to be powered by the car
Business model scalable to fleet level
Business model scalable to fleet level – first running project

- 1,250 apartments
- 2 MWh storage capacity
- 270 wallboxes
- 720 kWp photovoltaics

Pilot @ Wolfsburg, Germany
Activating unused renewable energy with the new storage capabilities

6,500 GWh/year in Germany are not used due to lack of storage capacity

2.7 million BEVs could be driving one year with the energy
Volkswagen will use battery production capacities for large scale storage including 2nd life options
Large scale storage as part of the **CLOSED LOOP**.

- **Battery cell**
- **Recycling**
- **Battery systems**
- **Second Use**
- **First Use**
Energy integration: Fully digital and data driven
Key Take-aways

_ Global Boost-Plan for charging infrastructure

_ Expand **fast charging** in strong partnership with **local partners**

_ The car will be a part of the **energy system**

_ **Storage systems** to facilitate fluctuating **renewable energy supply**

_ **Cloud based energy management**
OUR VISION & MISSION

With the right energy management and intelligent storage systems

ONE DAY, CHARGING WILL BE FOR FREE